ORIGINAL ARTICLE

Global, Regional, and Country-Specific Lifetime Risks of Stroke, 1990 and 2016

The GBD 2016 Lifetime Risk of Stroke Collaborators

ABSTRACT

BACKGROUND

The lifetime risk of stroke has been calculated in a limited number of selected populations. We sought to estimate the lifetime risk of stroke at the regional, country, and global level using data from a comprehensive study of the prevalence of major diseases.

METHODS

We used the Global Burden of Disease (GBD) Study 2016 estimates of stroke incidence and the competing risks of death from any cause other than stroke to calculate the cumulative lifetime risks of first stroke, ischemic stroke, or hemorrhagic stroke among adults 25 years of age or older. Estimates of the lifetime risks in the years 1990 and 2016 were compared. Countries were categorized into quintiles of the sociodemographic index (SDI) used in the GBD Study, and the risks were compared across quintiles. Comparisons were made with the use of point estimates and uncertainty intervals representing the 2.5th and 97.5th percentiles around the estimate.

RESULTS

The estimated global lifetime risk of stroke from the age of 25 years onward was 24.9% (95% uncertainty interval, 23.5 to 26.2); the risk among men was 24.7% (95% uncertainty interval, 23.3 to 26.0), and the risk among women was 25.1% (95% uncertainty interval, 23.7 to 26.5). The risk of ischemic stroke was 18.3%, and the risk of hemorrhagic stroke was 8.2%. In high-SDI, high-middle–SDI, and low-SDI countries, the estimated lifetime risk of stroke was 23.5%, 31.1% (highest risk), and 13.2% (lowest risk), respectively; the 95% uncertainty intervals did not overlap between these categories. The highest estimated lifetime risks of stroke according to GBD region were in East Asia (38.8%), Central Europe (31.7%), and Eastern Europe (31.6%), and the lowest risk was in eastern sub-Saharan Africa (11.8%). The mean global lifetime risk of stroke increased from 22.8% in 1990 to 24.9% in 2016, a relative increase of 8.9% (95% uncertainty interval, 6.2 to 11.5); the competing risk of death from any cause other than stroke was considered in this calculation.

CONCLUSIONS

In 2016, the global lifetime risk of stroke from the age of 25 years onward was approximately 25% among both men and women. There was geographic variation in the lifetime risk of stroke, with the highest risks in East Asia, Central Europe, and Eastern Europe. (Funded by the Bill and Melinda Gates Foundation.)

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The names and academic degrees of the authors, who are members of the Global Burden of Disease 2016 Lifetime Risk of Stroke Collaborators, are listed in the Appendix, and a list of the authors' affiliations is provided in the Supplementary Appendix, available at NEJM.org.

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Stroke accounts for almost 5% of all disability-adjusted life-years[1] and 10% of all deaths worldwide,[2] with the bulk of this burden (>75% of deaths from stroke and >80% of disability-adjusted life-years) occurring in low-income and middle-income countries.[3] According to several surveys, the global burden of stroke has been increasing,[1-3] and prevention of stroke may require an improved understanding of the risks among younger persons. Stroke prevention strategies in low-income and middle-income countries may differ from those adopted in high-income countries owing to differences in access to health care, health technologies, and relative rates of risk factors for stroke.[4]

Estimates of lifetime risk (defined as the cumulative probability of a disease developing in a person of a given age and sex during that person's remaining lifespan, after accounting for competing risks of death) provide a measure of disease risk in large populations.[5] Estimates of lifetime risk of stroke may be useful for the long-term planning of health systems.[6] In addition, estimates of lifetime risk of stroke across the age spectrum on a national level may be useful for gauging the effect of stroke prevention strategies.

Previous estimates of lifetime risk of stroke have been reported in a limited number of selected populations.[6-12] Diverging trends in stroke incidence and mortality rates have been observed between developed countries (where the rates are decreasing) and developing countries (where the rates are increasing)[13] against a background of increasing life expectancy in almost all countries.[14]

We used the results of the Global Burden of Disease (GBD) Study 2016, which estimated major disease burden from 1990 through 2016, to compare the estimated global, regional, and country-specific lifetime risks of stroke in 2016 with those in 1990. These estimates were stratified according to pathological subtype of stroke, age, sex, and sociodemographic index (SDI) and accounted for the competing risk of death from any cause other than stroke. The GBD is an ongoing global collaboration that uses all available epidemiologic data to provide a comparative assessment of health loss from 328 diseases across 195 countries and territories.

Methods

Estimating Stroke Incidence and Mortality

We used estimates from the GBD Study 2016[1,2] of the rate of first stroke, cause-specific mortality, and all-cause mortality at the global, regional (21 GBD regions nested within 7 GBD superregions), and national (195 countries) levels, stratified according to age and sex (Table 1; and Table S2 in the Supplementary Appendix, available with this the full text of this article at NEJM.org). Analyses were performed separately for ischemic stroke and hemorrhagic stroke; the latter included intracerebral hemorrhagic stroke and nontraumatic subarachnoid hemorrhagic stroke. The GBD Study 2016 used all available representative population-based data on incidence, prevalence, case fatality, and mortality to produce estimates of disease burden in 195 countries according to sex and 5-year age categories. Mortality was estimated by means of the Cause of Death Ensemble model, in which vital registration, verbal autopsy data (which included a written summary of events leading to a person's death as well as answers to standardized questions obtained by trained workers from families or other reliable informants in the local language), and country-specific covariates are used to estimate cause-specific mortality over time. Stroke incidence was estimated with the use of DisMod-MR, a Bayesian meta-regression disease-modeling tool. Details of the methods that we used to estimate stroke incidence and mortality have been previously published[3] and are summarized in the Supplementary Appendix.

Estimating Lifetime Risk of Stroke

Countries were categorized into quintiles of the SDI (high, high-medium, medium, medium-low, and low level of development) used in the GBD Study 2016.[15] The SDI, a composite indicator of development similar to the Human Development Index,[16] is based on country-level income per capita, average educational attainment among persons older than 15 years of age, and total fertility rate. We used stroke incidence, prevalence, and mortality rates in each 5-year age group to estimate the lifetime risk of stroke among persons at a given age. The lifetime risk of stroke at each age represents the cumulative risk of stroke from that age onward and is conditional on a person's survival to that age with-

Table 1. Global and Regional Lifetime Risks of Stroke in 2016 and Percentage Change in Lifetime Risk from 1990 to 2016 Among Men and Women and Both Sexes Combined.

Variable	Men		Women		Both Sexes Combined	
	Lifetime Risk	Percentage Change from 1990 to 2016	Lifetime Risk	Percentage Change from 1990 to 2016	Lifetime Risk	Percentage Change from 1990 to 2016
	*percent (95 percent uncertainty interval)**					
Global	24.7 (23.3 to 26.0)	15.4 (12.5 to 18.2)	25.1 (23.7 to 26.5)	3.2 (0.2 to 6.1)	24.9 (23.5 to 26.2)	8.9 (6.2 to 11.5)
Regional†						
High-income region						
Southern Latin America	17.8 (16.3 to 19.3)	−14.2 (−20.4 to −7.6)	20.6 (18.9 to 22.3)	−14.5 (−20.7 to −8.4)	19.2 (17.8 to 20.5)	−14.1 (−19.0 to −8.7)
Western Europe	22.2 (20.9 to 23.4)	4.2 (0.3 to 8.2)	23.3 (21.9 to 24.6)	−4.3 (−7.9 to −0.4)	22.7 (21.4 to 23.9)	0.4 (−3.6 to 3.1)
High-income North America	22.4 (21.1 to 23.7)	4.9 (1.7 to 8.7)	25.1 (23.6 to 26.4)	0.5 (−2.8 to 3.8)	23.8 (22.4 to 25.0)	2.7 (−0.3 to 5.9)
Australasia	20.9 (19.4 to 22.4)	8.1 (1.1 to 14.8)	23.0 (21.5 to 24.7)	1.4 (−4.6 to 7.9)	21.9 (20.6 to 23.4)	4.7 (−0.5 to 10.1)
High-income Asia–Pacific	22.2 (20.6 to 23.8)	−11.4 (−16.3 to −6.6)	23.5 (21.8 to 25.2)	−15.1 (−19.7 to −10.6)	22.8 (21.2 to 24.3)	−13.5 (−17.4 to −9.4)
Latin America and Caribbean						
Caribbean	18.0 (16.6 to 19.3)	1.3 (−4.5 to 6.8)	20.8 (19.3 to 22.3)	−0.3 (−6.1 to 5.9)	19.4 (18.0 to 20.7)	0.5 (−4.1 to 5.4)
Central Latin America	14.1 (13.1 to 15.1)	0.0 (−4.3 to 4.3)	16.4 (15.2 to 17.6)	−2.4 (−6.4 to 1.7)	15.2 (14.2 to 16.4)	−1.3 (−4.8 to 2.6)
Tropical Latin America	18.9 (17.6 to 20.2)	−10.4 (−13.9 to −6.6)	19.5 (18.1 to 20.9)	−15.1 (−18.8 to −11.0)	19.1 (17.9 to 20.5)	−12.8 (−16.0 to −9.2)
Andean Latin America	15.5 (14.0 to 17.0)	−0.9 (−9.0 to 8.1)	17.9 (16.2 to 19.6)	0.1 (−7.8 to 8.1)	16.7 (15.2 to 18.2)	0.3 (−6.7 to 6.5)
Sub-Saharan Africa						
Central sub-Saharan Africa	11.6 (10.6 to 12.7)	12.4 (3.8 to 20.8)	13.8 (12.6 to 15.1)	1.4 (−6.9 to 9.4)	12.8 (11.7 to 13.8)	6.1 (−0.9 to 12.9)
Eastern sub-Saharan Africa	11.2 (10.3 to 12.3)	13.8 (5.4 to 22.5)	12.5 (11.4 to 13.6)	6.7 (−0.1 to 13.9)	11.8 (10.9 to 12.8)	9.8 (3.8 to 16.1)
Southern sub-Saharan Africa	10.0 (9.2 to 10.9)	−18.1 (−23.8 to −12.3)	14.9 (13.7 to 16.1)	−14.0 (−18.9 to −9.0)	12.5 (11.6 to 13.5)	−15.4 (−19.9 to −11.1)
Western sub-Saharan Africa	13.0 (11.9 to 14.2)	10.5 (2.3 to 19.1)	15.8 (14.5 to 17.3)	7.0 (−0.6 to 15.8)	14.4 (13.3 to 15.7)	7.9 (2.0 to 14.4)
North Africa and Middle East	19.4 (17.8 to 20.9)	10.2 (4.7 to 15.7)	23.1 (21.4 to 24.8)	3.7 (−0.8 to 8.0)	21.2 (19.6 to 22.8)	6.4 (2.5 to 10.5)
South Asia	13.5 (12.5 to 14.5)	15.6 (11.0 to 20.0)	15.9 (14.7 to 17.1)	19.6 (14.5 to 24.6)	14.6 (13.6 to 15.7)	17.6 (13.6 to 21.3)
Southeast Asia, East Asia, and Oceania						
East Asia	40.6 (38.7 to 42.3)	35.9 (31.9 to 39.8)	36.3 (34.5 to 38.1)	20.7 (16.6 to 24.4)	38.8 (37.0 to 40.6)	29.7 (26.1 to 33.0)
Southeast Asia	19.6 (18.3 to 20.9)	6.9 (2.7 to 11.5)	20.0 (18.8 to 21.4)	14.2 (9.7 to 18.9)	19.8 (18.6 to 21.1)	10.4 (6.7 to 14.2)
Oceania	15.5 (13.8 to 17.2)	1.7 (−9.0 to 13.0)	16.5 (14.6 to 18.3)	1.6 (−9.2 to 12.8)	16.0 (14.2 to 17.6)	1.8 (−8.8 to 12.7)
Central Europe, Eastern Europe, and Central Asia						
Central Asia	22.7 (21.1 to 24.4)	−2.4 (−8.1 to 3.9)	26.1 (24.4 to 27.9)	−10.8 (−15.2 to −6.2)	24.4 (22.8 to 25.9)	−7.7 (−11.7 to −3.6)
Eastern Europe	26.8 (22.0 to 31.6)	−6.9 (−22.9 to 11.0)	36.5 (31.2 to 41.9)	−8.7 (−21.5 to 3.7)	31.6 (27.6 to 35.6)	−8.8 (−19.7 to 2.7)
Central Europe	29.8 (28.0 to 31.5)	13.9 (9.2 to 18.9)	33.7 (31.8 to 35.5)	4.2 (−0.2 to 8.7)	31.7 (30.0 to 33.3)	8.7 (4.8 to 12.8)

* The 95% uncertainty index represents the 2.5th and 97.5th percentiles around the point estimate.
† There are 21 Global Burden of Disease (GBD) Study regions nested within 7 GBD Study super-regions.

out having had a nonfatal stroke. Further details are provided in the Supplementary Appendix.

To account for the competing risks of stroke and death within a specific age group, we calculated the probability of both stroke and death from any cause other than stroke separately and then scaled the separate event probabilities to match the combined probability of both events. We calculated the lifetime risk only among persons 25 years of age or older because incidence rates of stroke among younger persons are low and are less dependent on modifiable risk factors and on the characteristics of health systems, which are associated with stroke burden in older populations.

STATISTICAL ANALYSIS

Point estimates and 95% uncertainty intervals representing the 2.5th and 97.5th percentiles around the estimate were used to compare results between groups. Differences in the estimates of the risk of stroke were considered to be significant when the 95% uncertainty intervals did not overlap or when the 95% uncertainty interval for relative percentage change did not include zero.

RESULTS

GLOBAL, REGIONAL, AND NATIONAL LIFETIME RISKS OF STROKE

In 2016, the global lifetime risk of stroke from the age of 25 years onward was 24.9% (95% uncertainty interval, 23.5 to 26.2), and there were regional and between-country differences (Table 1, and Table S3 in the Supplementary Appendix). China had the highest estimated risk (39.3%; 95% uncertainty interval, 37.5 to 41.1), and the risks were similarly high in Bosnia and Herzegovina, Bulgaria, Latvia, Macedonia, Montenegro, Romania, and Russia. Among the 21 GBD regions, East Asia had the highest risk (38.8%; 95% uncertainty interval, 37.0 to 40.6), followed by Central Europe (31.7%; 95% uncertainty interval, 30.0 to 33.3) and Eastern Europe (31.6%; 95% uncertainty interval, 27.6 to 35.6); eastern sub-Saharan Africa had the lowest risk (11.8%; 95% uncertainty interval, 10.9 to 12.8). When the risks were compared across SDI quintiles, the high-middle–SDI countries had the greatest risk (31.1%; 95% uncertainty interval, 29.0 to 33.0), followed by the middle-SDI countries (29.3%; 95% uncertainty interval, 27.8 to 30.8); the low-SDI countries had the lowest risk (13.2%; 95% uncertainty interval, 12.3 to 14.2). The risk was 23.5% (95% uncertainty interval, 22.2 to 24.8) in high-SDI countries.

COMPETING RISK OF DEATH FROM ANY CAUSE OTHER THAN STROKE

Because death from any cause other than stroke is a competing risk with respect to stroke and death from stroke, the hypothetical national lifetime risk of stroke was calculated under the assumption that all countries had the same mean risk of death from any cause other than stroke as that in the high-SDI countries, and the results are shown in Figures S1A through S1C and Table S5 in the Supplementary Appendix. In this hypothetical model, the lifetime risk of stroke would no longer be the lowest in sub-Saharan Africa. The largest increases in lifetime risk of stroke on account of a lower rate of death from any cause other than stroke in this scenario would be in Oceania (from 16% to 30%), sub-Saharan Africa (from 12% to 22%), and South Asia (from 15% to 21%). Smaller increases were seen in other low-SDI and middle-SDI countries; these findings reflect geographic variation in the competing risk of death from any cause other than stroke as a major determinant of lifetime stroke risk (Fig. S9A through S9R in the Supplementary Appendix).

LIFETIME RISK ACCORDING TO SEX, AGE, AND STROKE TYPE

In 2016, the global lifetime risk of stroke among men (24.7%; 95% uncertainty interval, 23.3 to 26.0) was not significantly different from that among women (25.1%; 95% uncertainty interval, 23.7 to 26.5) (Table 1), but there were regional and between-country differences in sex-specific risk (Table 1 and Fig. 1, and Fig. S10A and S10B in the Supplementary Appendix). The greatest risk among men was in China (41.1%; 95% uncertainty interval 39.2 to 42.9); among women in China, the risk was 36.7% (95% uncertainty interval, 35.0 to 38.6), which accounted for the largest difference in risk between men and women among the nations. The greatest risk among women was in Latvia (41.7%; 95% uncertainty interval, 37.7 to 45.4), and the risks among women in Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Lithuania, Macedonia, Monte-

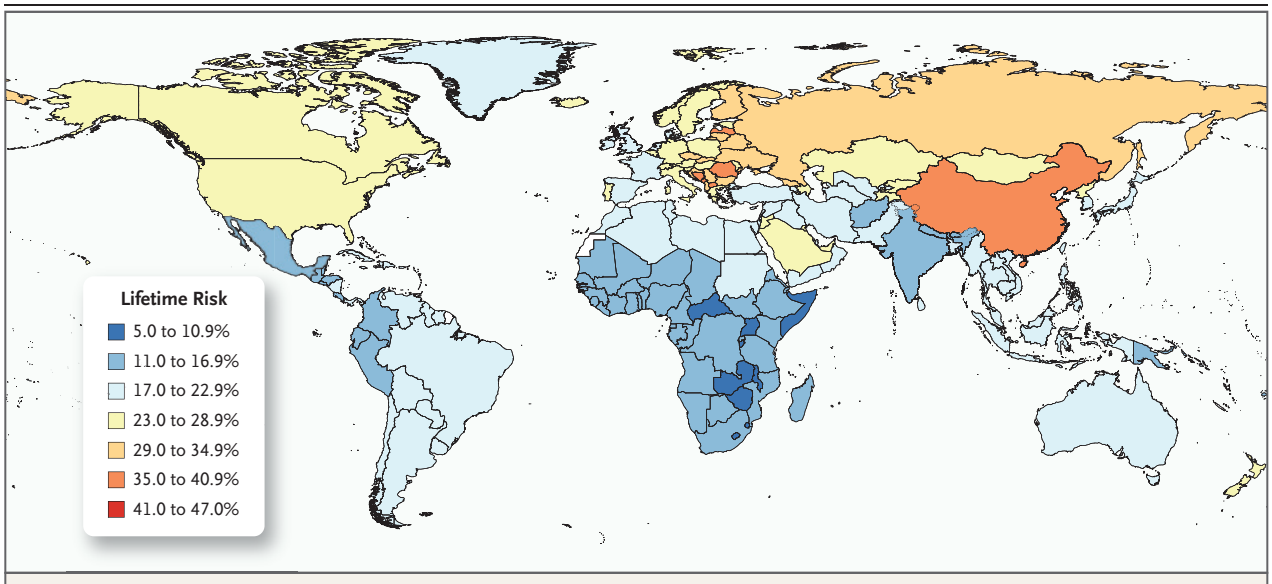

Figure 1. Global Lifetime Risk of Stroke in Both Sexes Combined, 2016.

negro, Romania, Russia, Serbia, Slovakia, and Ukraine were similar. Among 21 GBD regions, the highest lifetime risk among men was in East Asia (40.6%; 95% uncertainty interval, 38.7 to 42.3), whereas the highest lifetime risks among women were in both Eastern Europe (36.5%; 95% uncertainty interval, 31.2 to 41.9) and East Asia (36.3%; 95% uncertainty interval, 34.5 to 38.1) (Table 1, and Fig. S2B and S2C in the Supplementary Appendix).

When the lifetime risk of stroke was compared between women and men on a regional basis, the risk was significantly higher among women in central Latin America, southern and western sub-Saharan Africa, North Africa and the Middle East, South Asia, and Central Europe. There was less variation according to sex in the lifetime risk of hemorrhagic stroke than in the risk of ischemic stroke. The lifetime risk of ischemic stroke was approximately double that of hemorrhagic stroke among both men and women across different regions and SDI quintiles (Tables S3 and S6 in the Supplementary Appendix).

In 2016, the remaining lifetime risk of stroke at age 25 years and at age 70 years did not differ significantly for either sex (24.7% [95% uncertainty interval, 23.3 to 26.0] and 22.6% [95% uncertainty interval, 21.0 to 24.1], respectively, among men and 25.1% [95% uncertainty interval, 23.7 to 26.5] and 22.3% [95% uncertainty interval, 20.6 to 23.9], respectively, among women) (Table 1, and Table S3 and Fig. S11A and S11B in the Supplementary Appendix). For each age category greater than 70 years, the remaining lifetime risk of stroke decreased, reaching 13.4% (95% uncertainty interval, 11.8 to 15.1) among adults 95 years of age (Fig. 2, and Table S7 in the Supplementary Appendix).

Similar age patterns in lifetime risk were apparent for both ischemic stroke and hemorrhagic stroke across all SDI quintiles, with less difference between age groups in the risk of hemorrhagic stroke in low-middle–SDI and low-SDI countries (Fig. S4 through S8 in the Supplementary Appendix). The sum of the lifetime risks of ischemic stroke and hemorrhagic stroke, as determined in separate analyses, was greater than the risk of stroke because it is possible to have both subtypes of stroke over a lifetime.

LIFETIME RISK IN 2016 AS COMPARED WITH 1990

The estimates of global lifetime risk of stroke increased from 22.8% in 1990 to 24.9% in 2016, representing a relative increase of 8.9% (95% uncertainty interval, 6.2 to 11.5) (Table 1, and Table S4 in the Supplementary Appendix); the difference is significant, as reflected by the exclusion of zero in the uncertainty interval. The increase in the risk was greater among men (15.4%; 95% uncertainty interval, 12.5 to 18.2) than among women (3.2%; 95% uncertainty interval, 0.2 to 6.1), and the increase in the risk of

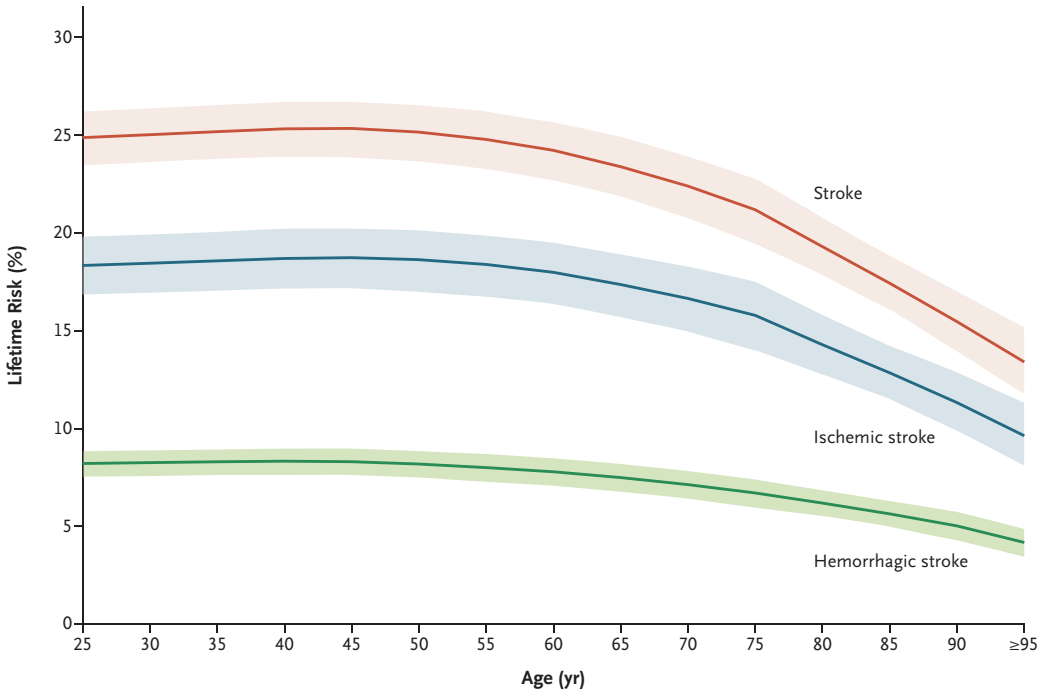

Figure 2. Global Lifetime Risks of Stroke According to Pathological Subtype and Age, 2016.

Shown is the relationship between lifetime risk of stroke and age. Lifetime risk is the cumulative probability of a disease developing in a person of a given age and sex during that person's remaining lifespan, after accounting for competing risks of death); the modeled age starts at 25 years. Each colored line represents a trend of the relationship for the specified pathological subtype of stroke, and the shaded area around each line represents the 95% uncertainty interval. The category of stroke included ischemic stroke and hemorrhagic stroke.

ischemic stroke (12.7%; 95% uncertainty interval, 8.9 to 16.3) was greater than that of hemorrhagic stroke (4.0%; 95% uncertainty interval, 0.2 to 7.6). The lifetime risk of stroke in western and eastern sub-Saharan Africa, North Africa and the Middle East, Central Europe, East Asia, South Asia, and Southeast Asia increased significantly between 1990 and 2016. The risk in Central Asia, southern and tropical Latin America, high-income Asia–Pacific, and southern sub-Saharan Africa decreased significantly between 1990 and 2016. In the remaining GBD regions, there were no significant changes in the estimated risk between these years.

DISCUSSION

The global lifetime risk of stroke from the age of 25 years onward is estimated to have increased from 22.8% in 1990 to 24.9% in 2016, with the change in the risk of ischemic stroke exceeding that of hemorrhagic stroke. This increase is the result of unchanged or increasing stroke incidence in many middle-SDI countries and declines in the competing risks of death from any cause other than stroke. The estimated global lifetime risk of stroke has declined with increasing age, in part owing to age-related competing risks of other diseases. In low-SDI countries (generally, countries with the youngest populations, such as those in sub-Saharan Africa), the estimated lower lifetime risk of stroke is the result of a high competing risk of death from any cause other than stroke at both younger and older ages and does not necessarily represent a lower incidence of stroke or more effective prevention and treatment strategies.[2,17]

Many of the national estimated lifetime risks of stroke reported here are similar to or higher than those observed in specific populations in

the same country in studies other than the GBD Study, such as in the Framingham Heart Study cohort in the United States (lifetime risk of stroke of 21.1% among women and 16.9% among men),[18] in a Japanese cohort (lifetime risk of stroke of 18.9% among men and 20.2% among women),[8] and in a Chinese cohort (lifetime risk of stroke of 18.0% among men and 14.7% among women).[7] A study of stroke in the Netherlands showed that the risk among men was 22.8%, which is similar to our estimate for that country, but the risk among women (29.8%) was lower than our estimate.[9] We estimated ischemic stroke to be more frequent than hemorrhagic stroke — a finding that is similar to those of other population-based studies.[6,8,12,13,19]

Regional variation in lifetime cardiovascular risk across subpopulations has been shown previously in the Cardiovascular Lifetime Risk Pooling Project and is compatible with our finding of large geographic variation in lifetime risk of stroke.[10] Our findings that the lifetime risk of stroke is similar among men and among women are in accord with some other observations; however, there have been studies[8-10,19] in which the risk was greater among women than among men, and the reasons for these differences between studies are unclear. In the comparative risk assessment performed in the GBD Study,[4,20] elevated blood pressure was estimated as the leading attributable risk factor for stroke across all SDI quintiles, with greater attribution to air pollution and low intake of fruit in low-SDI countries and high body-mass index and high fasting plasma glucose levels in high-SDI countries.

The use of estimates of lifetime risk of disease is a new metric for the GBD Study, which has previously published summary measures of health including years of life lost prematurely, years lived with disability,[2,3,20] and stroke burden associated with various risk factors.[4] Knowledge of lifetime risk may be useful for stroke prevention and public education. High estimates of lifetime risk of stroke suggest that there is possible value of measures for the primary prevention of stroke throughout a person's lifespan and suggest that strategies to reduce cardiovascular risk remain relevant for both younger and older adults.

The main strength of our study was the systematic use of data and methods that allow for comparable estimates of lifetime risk of stroke among different locations and between different years. We provide estimates of lifetime risk of stroke only among persons 25 years of age or older in contrast to other studies that estimated lifetime risk of stroke among persons 45 years of age or older.[6,8-10] Furthermore, the estimates of lifetime risk of stroke that we provide account for competing risk of death from any cause other than stroke and represent whole populations, possibly making the results generalizable.

The epidemiologic approaches used in our study have limitations. The accuracy of the estimates of lifetime risk of stroke was limited by the accuracy and availability of epidemiologic data from the countries studied. There was a lack of sufficient epidemiologic data on stroke incidence and case fatality for most countries in the world. In these countries, estimates were dependent on geospatial statistical models that incorporated data from neighboring countries and data on country-level risk exposure. The ability to differentiate stroke from other acute neurologic events and to differentiate ischemic from hemorrhagic stroke was impeded by the nature of health system in each country, differences in clinical practice or availability of health care, the technology available to diagnose strokes, and the customary manner of coding disease entities in each country. We did not differentiate between subarachnoid hemorrhagic and intracerebral hemorrhagic stroke; these were combined in the estimate of hemorrhagic stroke. There is significant variation in stroke burden within large countries, and our results represent only the mean national risk. Finally, we analyzed only the lifetime risk of first-ever stroke and not recurrent stroke.

In conclusion, our study provided global, regional, and country-specific estimates of the lifetime risk of stroke according to sex and age, although the precision of the estimates is limited by insufficient data in some countries. The global lifetime risk of stroke is approximately 25% starting at the age of 25 years among both men and women, and there is large geographic variation, with a particularly high lifetime risk of stroke in East Asia, Central Europe, and Eastern Europe.

The views expressed in this article are those of the authors and do not necessarily represent the views of the National Heart, Lung, and Blood Institute, the National Institutes of Health, or the Department of Health and Human Services.

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Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.

APPENDIX

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